

CLAIMS

What is claimed is:

1. A method, comprising:

 assigning a plurality of upper-level addresses based on an upper-level protocol to a Fibre Channel (FC) node device in a communications system, the FC node device supporting the FC protocol at a base layer; and

 configuring each FC node device in the communications system to resolve an upper -level address into an address based on the FC protocol.
2. The method of claim 1, wherein the high-level protocol is a network protocol.
3. The method of claim 2, wherein the network protocol is the Transmission Control Protocol over the Internet Protocol (TCP/IP), and the upper-level addresses are IP addresses.
4. The method of claim 1, wherein assigning the plurality of upper-level addresses comprises encoding the multiple upper-level addresses within the symbolic name of the FC node device based on a predefined encoding scheme.
5. The method of claim 4, wherein the predefined encoding scheme includes using selected bytes the symbolic name field defined in the FC protocol to store the plurality of upper-level addresses.

6. The method of claim 1, wherein configuring each FC node device comprises configuring the FC node device to send a RFT_ID message to a name server for a FC fabric that enables communications between the FC node devices, and to send a RSPN_ID message to the name server.

7. The method of claim 6, wherein configuring each FC node device comprises, configuring the FC node device to send a GID_FT message to the name server, to send a GSPN_ID message to the name server for each port identified in a response to the GID_FT message, to compare the upper-level address with the addresses encoded in a symbolic name received in response to the GSPN_ID message, and to map the upper-level address to a port ID of the FC node device that has the upper-level address encoded in its symbolic name.

8. A method for building a failover-enabled communications system, the method, comprising:

clustering a plurality of Fibre Channel (FC) node devices to form a failover cluster;

establishing a primary link between a first FC node device in the failover cluster and a FC node device outside the failover cluster; and

in the event of failure of the primary link, establishing a backup link between the FC node device outside the failover cluster and a second FC node device in the failover cluster.

9. The method of claim 8, wherein clustering the plurality of FC node devices comprises assigning multiple upper-level protocol addresses to each of the FC node devices.

10. The method of claim 9, wherein assigning the upper-level addresses comprises assigning at least a primary IP address and a backup IP address to each FC node device in the failover cluster.

11. The method of claim 8, further comprising encoding the multiple IP addresses within a symbolic name for each FC node device using a predefined encoding scheme.

12. The method of claim 11, wherein the predefined encoding scheme includes using selected bytes in a symbolic name field defined in the FC protocol to store the IP addresses.

13. The method of claim 11, wherein the clustering comprises causing each FC node device in the failover cluster to register its symbolic name with a name server for an FC fabric with which the FC node devices are connected.

14. A method for building a failover-enabled communications system, the method, comprising:

establishing a primary link between a first FC node device and a second FC node device;

configuring a third FC node device to act as a failover node for the second FC node device, wherein the third FC node device is assigned an upper-level protocol alias address that corresponds to an upper-level protocol address of the second FC node device; and

upon a failure of the primary link, establishing a backup link with the third FC node device.

15. The method of claim 14, wherein the upper-level protocol address is an Internet Protocol (IP) address.

16. The method of claim 14, wherein the primary link is established through a first FC fabric and the backup link is established through a second FC fabric.

17. The method of claim 16, wherein establishing the backup link comprises notifying the third FC node device of the failure of the primary link, causing the third FC node device to perform a registration procedure, and causing the first FC node device to perform a discovery procedure.

18. The method of claim 17, wherein the registration procedure comprises causing the third FC node device to register a symbolic name for the third FC

node device with a name server for the second FC fabric, wherein the symbolic name is encoded with the IP address of the second FC node.

19. The method of claim 18, wherein the discovery procedure comprises causing the first FC node device to retrieve the symbolic name of all FC node devices connected to the second FC fabric, to analyze each symbolic name to find the symbolic name that is encoded with the IP address of the second FC node device, and to determine a port identifier for the third FC node device based on the symbolic name.

20. The method of claim 17, wherein notifying the third FC node device is through a private point-to-point link between the second FC node device and the third FC node device.

21. A storage device, comprising:

a processor;

a memory coupled to the processor, the memory storing instructions which when executed by the processor cause the storage device to perform a method comprising:

receiving input of a plurality of IP addresses to be associated with a Fibre Channel (FC) N_Port of the storage device; and

storing the plurality of IP addresses as a symbolic name within a symbolic name field for the FC N_Port.

22. The storage device of claim 21, wherein the method further comprises performing a registration procedure to register the symbolic name, and each communications protocol supported by the FC N_Port with a name server for the FC fabric to which the FC N_Port is connected.

23. The storage device of claim 22, wherein the multiple IP addresses comprise a primary IP address and a backup IP address, and the registration procedure comprises a first registration operation to register the primary IP address, and a second registration operation to register the backup IP address.

24. The storage device of claim 23, wherein the first registration operation and the second registration operation are the same registration operation.

25. The storage device of claim 23, wherein the method further comprises detecting a failure of a primary link between a pair of remote N_Ports, wherein one of the remote N_Ports has the backup IP address as a primary IP address.

26. The storage device of claim 25, wherein the second registration operation is performed after detecting the failure.

27. A computer readable medium, having stored thereon on a sequence of instructions which when executed by a processor for a storage device, causes the storage device to perform a method comprising:

receiving input of a plurality of IP addresses to be associated with a Fibre Channel (FC) N_Port of the storage device; and

storing the plurality of IP addresses as a symbolic name within a symbolic name field for the FC N_Port.

28. The computer readable medium of claim 27, wherein the method further comprises performing a registration procedure in which the multiple IP addresses and communications protocols supported by the FC N_Port is registered with a name server for a FC fabric to which the FC N_Port is connected.

29. The computer readable medium of claim 28, wherein the multiple IP addresses comprise a primary IP address and a backup IP address, and the registration procedure comprises a first registration operation to registration the primary IP address and a second registration operation to register the backup IP address.

30. The computer readable medium of claim 29, wherein the first registration operation and the second registration operation are the same operation.

31. The computer readable medium of claim 29, wherein the method further comprises detecting a failure of primary link between a pair of remote N_Ports, wherein one of the remote N_Ports has the backup IP address as a primary IP address.

32. The computer readable medium of claim 31, wherein the second registration operation is performed after detecting the failure.